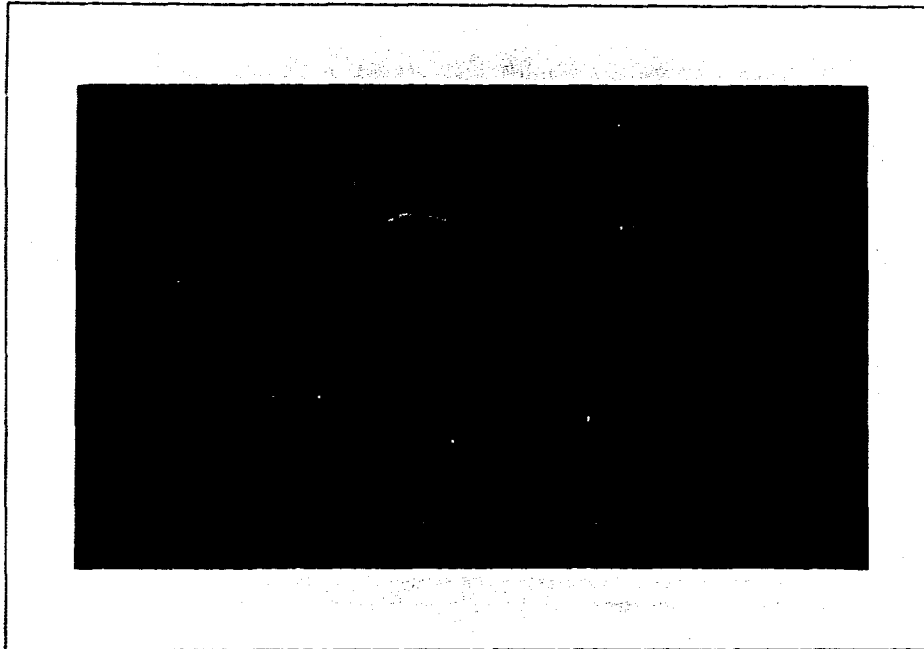


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BOUNDED RATIONALITY AND ORGANIZATIONAL LEARNING

Technical Report AIP - 107

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September 23, 1989

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Bounded Rationality and Organizational Learning

Herbert A. Simon
Carnegie-Mellon University

As I understand it, the manifest function of this gathering is to discuss the topic of organizational learning, whereas the latent function is to honor James March. Or is it the other way around? In either case, it is a valuable and pleasurable undertaking. Shakespeare subdivided human life into five major stages. We can refine the latter portion of his scale by taking note, at any given time in our lives, of whom we are just then honoring. Not long after we received our Ph.Ds., it was time to honor our teachers, as they began to reach the appropriate level of dignity for such accolades. A couple of decades later, we found ourselves honoring our contemporaries and colleagues. Still later, those of us who are lucky enough to survive have the opportunity of honoring our students.

Of course, Jim March was *never* my student. (In my memory of him, back to our earliest acquaintance, he never exhibited that quality of docility that befits students.) Nevertheless, I did offer him his first job, and he did accept. Offering was easy. I met him in New Haven, had dinner with him, and reached an immediate decision. I probably had to clear the decision with the Dean, Lee Bach, but in those happy days we didn't worry about faculty committees, so it didn't take long. I recount all this as evidence of my sound judgment and ability to learn very rapidly. But it wasn't very hard, at that dinner, to learn that I was dealing with a young political scientist of unusual promise. And how right I was!

The Organizational Level

One can question whether this anecdote serves as an example of organizational learning -- my assigned topic. It was learning by an individual that had consequences for an organizational decision -- it provided new factual decision premises that led to an offer. But we must be careful not to adopt too strict a definition of organizational learning, or we will define our topic out of existence, thereby denying the legitimacy of this conference. All learning takes place inside individual human heads; an organization learns in only two ways: (a) by the learning of its members, or (b) by ingesting new members who have knowledge the organization didn't previously have.

But what is stored in any one head in an organization may not be unrelated to what is

stored in other heads; and the relation between those two (and other) stores may have a great bearing on how the organization operates. What an individual learns in an organization is very much dependent on what is already known to (or believed by) other members of the organization and what kinds of information are present in the organizational environment. As we shall see, an important component of organizational learning is internal learning -- that is, transmission of information from one organizational member or group of members to another. Individual learning in organizations is very much a social, not a solitary, phenomenon.

However, we must be careful about reifying the organization and talking about it as "knowing" something or "learning" something. It is usually important to specify *where* in the organization particular knowledge is stored, or *who* has learned it. Depending on its actual locus, knowledge may or may not be available at the decision points where it would be relevant. Since what has been learned is stored in individual heads (or in files or data banks), its transience or permanence depends on what people leave behind them when they depart from an organization or move from one position to another. Has what they have been learned been transmitted to others or stored in ways that will permit it to be recovered when relevant?

The justification of a conference on organizational learning, exemplified in the papers already presented, is that human learning in the context of an organization is very much influenced by the organization, has consequences for the organization and produces phenomena at the organizational level that go beyond anything we could infer simply by observing learning processes in isolated individuals. It is those consequences and those phenomena that we are trying to understand here. And my task is to show how some of those consequences and phenomena arise from the fact that human rationality is very approximate in the face of the complexities of everyday organizational life. Along the way, I will have some comments on ways in which we can do research and thereby gain new knowledge about these phenomena -- learn about organizational learning.

Let me persevere for a moment on that term "organizational level." Readers of the book, *Organizations* (1958), that Jim March and I wrote more than thirty years ago have sometimes complained that it was not a book on organizations at all but on the social psychology of people living in an organizational environment. The complaint was usually registered by sociologists, and was not without merit.

We need an organization theory because some phenomena are more conveniently

described in terms of organizations and parts of organizations than in terms of the individual human beings who inhabit those parts. There is nothing more surprising in the existence of those phenomena than in the existence of phenomena that make it convenient for chemists to speak about molecules rather than quarks. Employing a more aggregate level of discourse is not a declaration of philosophical anti-reductionism, but simply a recognition that most natural systems do have hierarchical structure, and that it is sometimes possible to say a great deal about aggregate components without specifying the details of the phenomena going on within these components.

Hence, in what follows, I will have little or nothing to say about the mechanisms that enable an individual human being to learn, but will focus on the ways in which information is acquired by organizations, is stored in them, and is transmitted from one part of an organization to another. I will be concerned with what are usually called emergent phenomena at the organizational level, and hope that sociologists will find this essay more "organizational" than was our book.

The Structure of Roles

For purposes of discussing organization learning, organizations are best viewed as systems of interrelated roles, and that is the way I have been viewing them here. How can we conceptualize roles so as to make this concept useful for organization theory?

The point has perhaps not been emphasized in the sociological literature as often as it should be that a role is not a system of prescribed behaviors but a system of prescribed decision premises. Roles tell organization members how to reason about the problems and decisions that face them: where to look for appropriate and legitimate informational premises and goal (evaluative) premises, and what techniques to use in processing these premises. The fact that behavior is structured in roles says nothing, one way or the other, about how flexible or inflexible it is.

Each of the roles in an organization presumes the appropriate enactment of the other roles that surround it and interact with it (See Martha Feldman, this volume). Thus, the organization is a role system.

Organizational Learning and Innovation

Since the organizations I know best are universities, and since I have not engaged in recent years in any systematic organizational research, I will have to draw upon my university experiences for most of my examples of organizational learning phenomena. I believe that universities qualify as one of the species of what Bill Starbuck has called "knowledge intensive organizations." Let us take the case of a university that wants to innovate along some dimension of educational practice -- perhaps by building its instruction around the Great Books, or by focusing on something it calls liberal-professional education. I'll use the latter example, which is closer to home.

The graduate schools from which a university draws its new teachers are organized in disciplines, some of which are saturated with the values of liberal education (and transmit them to their students), others of which are devoted to professional education. There are no disciplines, to the best of my knowledge, that fly the banner of "liberal-professional" education. Clearly, a university that wishes to implement this kind of instruction is faced with a major learning problem for its new (and probably its old) faculty members. It has no chance of accomplishing its goal without substantial education, and reeducation, of its inductees. Moreover, the reeducation is not a one-time task but a continuing one, unless the educational climate of the envioning society changes so that it begins to produce graduates already indoctrinated with the desired goals.

Effects of Turnover

Turnover in organizations is sometimes (see Tushman, Virany and Romanelli, this volume) considered a process that facilitates organizational innovation -- getting out of the current rut. But in the case before us, where the organization is trying to distance itself from general social norms, turnover becomes a barrier to innovation, because it increases training (socialization) costs (See Carley, this volume). To preserve its distinct culture, an organization of this kind may try to train its own personnel from the ground up, instead of relying on outside institutions to provide that training. Such inbreeding will have other organizational consequences. (I state these conclusions very confidently, but they should really be stated as researchable hypotheses.)

Contrast this with the organization that finds in its environment training organizations that share a common culture with it. The Forest Service, in Herbert Kaufman's (1960) classical account of it, is such an organization, counting on Schools of Forestry to provide it with new employees who are already indoctrinated with its values and even its standard operating

procedures. The same thing occurs, less precisely but on a larger scale in such professions as engineering, where there are close links between the engineering colleges and the industries, with a feedback of influence from industry to the engineering curricula.

An Experiment on Stability

If turnover is sufficiently low, organizational values and practices can be stabilized by the fact that each new inductee finds himself or herself confronted with a social system that is already well established and prepared to mold newcomers to its procedures. This phenomenon can be produced in the laboratory (and I believe actually *has* been produced, but I cannot put my hands on the appropriate reference).

In a certain experimental paradigm in social psychology (often called the Bavelas communication network) different patterns of communication are induced in five-person groups. In one pattern (the wheel) one member of the group serves as leader or coordinator and all the other members communicate with him or her, and not directly with each other. In another pattern (the circle) the members are arranged in a symmetric circular network, each member communicating only with the two who are immediately adjacent. The groups are performing a task that requires them to share information that is given to the members individually (Bavelas, 1950).

Now consider two groups whose members are A1, A2, A3, A4, A5, and B1, B2, B3, B4, B5, respectively, where the A's are in the wheel pattern and the B's in the circle pattern. After they are thoroughly trained in the task, we open all the communication channels so that each member can communicate directly with all the others in that group. If they are under sufficient pressure to perform rapidly, the first group will likely continue to use the wheel pattern of communication and the second group the circle pattern.

After a number of additional trials, interchange A1 with B1. One would predict that the groups would continue to use their respective patterns. After a few more trials, interchange A2 with B2, then A3 with B3, and so on until the original wheel group is populated by B1 through B5, and the original circle group by A1 through A5. We would predict that the A's would now be communicating in a circle pattern and the B's in a wheel pattern. As I said, I believe the experiment has been run, but I do not know where the results were published. If it works as predicted, it demonstrates an emergent property of an organization – a persistence of pattern that survives a complete replacement of the individuals who enact the pattern.

Let us return to the topic of organizations that deviate from their surrounding cultures. The example of the deviant university can be extended to virtually all organizational innovation. Among the costs of being first -- whether in products, in methods of marketing, in organizational procedures, or what not -- are the costs of instilling in members of the organization the knowledge, beliefs, and values that are necessary for implementing the new goals. And these costs can be exceedingly large (as they are in the case I used as example). The tasks of management are quite different in organizations that can recruit employees who are pre-fashioned, so to speak, than they are in organizations that wish to create and maintain, along some dimensions, idiosyncratic subcultures.

A major topic, therefore, in organizational learning is an understanding of the mechanisms that can be used to enable an organization to deviate from the culture in which it is embedded. As my university example suggests, this topic can be examined in the field, and particularly in a historical vein, by following the course of events in organizations that are identified as distancing themselves along one or more dimensions from the surrounding culture. If we are concerned about the imprecision of case studies as research data, we can console ourselves by noting that a man named Darwin was able to write a very persuasive (perhaps even correct) book on the origin of species on the basis of a study of the Galapagos Islands and a few other cases. To the best of my recollection, there are no statistics in Darwin's book.

Organizational Memory

The process of retaining unique traits within an organization is a part of the more general phenomena of organizational memory. Since much of the memory of organizations is stored in human heads, and only a little of it in procedures put down on paper (or held in computer memories), turnover of personnel is a great enemy of long-term organizational memory. This natural erosion of memory with time has, of course, both its advantages and disadvantages. In the previous section I emphasized one of its disadvantages. Its advantage is that it automatically removes outdated irrelevancies (but without discriminating between the relevant and the irrelevant). Leaving aside the erosion problem, how are we to characterize an organization's memories?

Research in cognitive psychology in recent years has made great progress in understanding human expertise (Simon, 1981, Chapter 4). What has been learned can be summed up in a few generalizations. First, expertise is based on extensive knowledge -- no

knowledge, no expertise. A world-class expert in any field (several domains have been studied in some detail) holds in memory some 50,000 chunks (familiar units) of relevant information. (The 50,000 should not be taken too literally, but it is correct within an order of magnitude.)

This body of knowledge is stored in the form of an indexed encyclopedia, which is technically referred to as a *production system*. Associated with each chunk is a set of cues which, whenever evoked by a stimulus, will provide access to that chunk in semantic memory. The memory content may be of many kinds: the name associated with the cue, information about the cued phenomenon, things to do about it, and so on. The physician who sees the symptom (the cue) is reminded of the name of a disease often associated with it, information about the likely course of the disease, possible medical action to cure it, additional tests that would increase the reliability of the diagnosis, and so on.

Armed with knowledge stored in his or her production system, the expert is prepared (but only in the domain of expertise) to respond to many situations "intuitively" -- that is, by recognizing the situation and evoking an appropriate response, -- and also to draw on the stored productions for more protracted and systematic analysis of difficult problems.

We know also that no one -- literally no one -- becomes a world class expert in any professional domain with less than ten years of full-time dedication to learning, to acquiring the 50,000 indexed chunks organized in the production system. The evidence for this time requirement is overwhelming, and child prodigies provide no exceptions (Bloom, 1985; Hayes, 1989, Chapter 11).

Against the background of this picture of expertise, the memories of an organization can be represented as a vast collection of production systems. This representation becomes much more than a metaphor as we see more and more examples of human expertise captured in automated expert systems. One motive for such automation, but certainly not the only one, is that it makes organizational memory less vulnerable to personnel turnover.

Ingesting Innovations from Without

My previous example had to do with organizations trying to retain their identities in a world of alien ideas, fighting the threat of increasing entropy that comes with the ingestion of personnel. The other side of the coin is the problem of assimilating innovations that originate outside the organization, or that have to be transmitted from a point of origin in the organization to points of

implementation. Here, let me take the research and design process as my example, but again in the context of universities (For a different kind of example, see Woody Powell, this volume). The translation to corporate situations will follow.

Research as a Learning Mechanism

So-called research universities usually proclaim that they have a dual mission: to create new knowledge and to transmit that knowledge to their students. Research accomplishes the former, and instruction the latter. Of course the real pattern is much more complicated than that. In the first place, the new knowledge produced by research is usually not initially transmitted to students at the same university, but to researchers throughout the world, mainly by publication. In the second place, most of the knowledge transmitted to students in a university is not produced at that university. Is there really any reason why the research (which is one process of learning) and the instruction (another learning process) should go on in the same institution?

When we examine the research process more closely, we see that it differs rather fundamentally from the usual description. In any given research laboratory, only a tiny fraction of the new knowledge acquired by the research staff is knowledge created by that laboratory; most of it is knowledge created by research elsewhere. We can think of a research scientist as a person who directs one eye at Nature and the other at the literature of his or her field. And in most laboratories, probably all laboratories, much more information comes in through the eye that is scanning the journals than the eye that is looking through the laboratory microscope.

It is probably true, and certainly widely suspected, that in any field of research a large fraction of the less distinguished laboratories could vanish without seriously reducing the rate at which new knowledge is created. Does that mean that these dispensable laboratories (dispensable in terms of the creation of knowledge) do not pay their way? The conclusion does not follow if the main function of a laboratory is not the creation of knowledge but the acquisition of knowledge. In military parlance, we would label such laboratories intelligence units rather than research units. They are units of the organization that are specialized for the function of learning from the outside world (and perhaps, incidentally, sometimes creating new knowledge themselves).

As a matter of fact, in our more honest moments in universities, we sometimes recognize the intelligence function of "research." When we are asked why we require faculty members who are primarily teachers to publish in order to gain promotion or tenure, we answer that if they do

not do research. they will not remain intellectually alive. Their teaching will not keep up with the progress of their disciplines. It is not their research products that we value, but their engagement in research which guarantees their attention to the literature -- to the new knowledge being produced elsewhere.

It can be highly dysfunctional for a laboratory to live with the belief that its main product is the new knowledge produced by its in-house research. Such a belief produces the NIH (Not Invented Here) phenomenon, with a consequent reinvention of many wheels.

R&D and Manufacturing

The problems of organizational learning have just begun when an intelligence unit extracts some possibly relevant new knowledge from the environment (or invents it itself). The problem of developing new products from (local or imported) research ideas and of carrying them to the stage of successful manufacture and marketing is a classical organizational problem of this kind. A successful product must satisfy a whole range of constraints, the knowledge of which may originate in many parts of the organization. Among these are constraints on product characteristics determined by end use and markets, constraints determined by manufacturing considerations, and constraints determined by natural laws over and above those involved in the nuclear concept.

End use and Market Constraints. An idea for a better mousetrap originating in a research laboratory has to satisfy the needs and demands of real-world markets. Research and development is usually conceived to begin with a key scientific idea which is elaborated through a development process. The development process annexes a succession of constraints to the initial research idea, continually modifying the idea until it satisfies them (or until it appears that they cannot be satisfied). Acquiring knowledge of the appropriate constraints is an important learning process, since that knowledge is generally widely distributed throughout the organization and elsewhere, and is seldom all available to the research and development staff at the beginning of the process (Simon, 1976, Chapter 17).

In some industries, control gear would be an example, a considerable fraction of ideas for new products originates with a knowledge of customers' needs and problems -- the nature and uses of the equipment to be controlled. In these cases, the sales engineers need to be incorporated in the intelligence process that initiates new product development. Here there is a reverse flow of instruction from the usual conception of the R&D process.

In whichever direction the ideas flow through the organization, it is clear that nothing will happen unless they do flow. Normally, the learning associated with a new product must be highly diffused through the organization -- many people have to learn many things, and such lateral diffusion and transfer is far from automatic or easy. It must overcome motivational obstacles (I have already mentioned the NIH syndrome), and it must cross cognitive boundaries.

Manufacturing Constraints. A common complaint about contemporary American practice in new product design is that the design process is carried quite far before manufacturing expertise is brought to bear on it. But ease and cheapness of manufacture can be a key to the prospects of a product in competitive markets, and failure to consider manufacturability at an early stage usually causes extensive redesign with a corresponding increase in the time interval from initial idea to a manufactured product. These time delays are thought to be a major factor in the poor showing of many American industries in competing with the Japanese.

We know some, if not all, of the conditions for making communications between designers and manufacturing engineers effective. Each group must respect the expertise of the other, and must acknowledge the relevance of that expertise to their own problems. Moreover, each must have a sufficient knowledge and understanding of the others' problems to be able to communicate effectively about them. Experience shows that these conditions are unlikely to be satisfied unless members of each group (or a sufficient number of members of each group) have had actual experience with the activities and responsibilities of the other group. In typical Japanese manufacturing practice, this shared understanding and ability to communicate is brought about by extensive lateral transfer of engineers in the course of their careers.

These examples will illustrate some of the kinds of learning involved, some of the problems of bringing it about, and some of the mechanisms for solving those problems when an organization brings in innovations from outside or tries to transport them from one organizational unit to another.

Acquiring New Problem Representations

In my earlier discussion of a culturally deviant organization, I contrasted the way in which roles (decision premises) are acquired in such an organization from the way in which they are acquired in an organization that builds upon the culture of the society that provides it with new members.

In my discussion of research and development, I examined the ways in which new decision premises may be injected into organizations and diffused through them. In neither discussion did I distinguish sharply between learning that brings new knowledge to bear within an existing culture and knowledge that changes the culture itself in fundamental ways. I would like to turn now to that distinction (which clearly is a relative, and not an absolute one).

In the literature of problem solving, the topic I am now taking up is called "problem representation." In the past thirty years, a great deal has been learned about how people solve problems by searching selectively through a problem space defined by a particular problem representation. Much less has been learned about how people acquire a representation for dealing with a new problem -- one they haven't previously encountered (But see the chapters by Van de Ven, and by March, Sproull and Tamiz, this volume).

Two cases must be distinguished: (1) The learner is presented with an appropriate problem representation, and has to learn how to use it effectively. That is essentially what is involved when organizations, already formed, ingest new members from an alien culture. (2) The organization is faced with a totally new situation, and must create a problem representation to deal with it, then enable its members to acquire skill in using that representation. In the extreme case, a new organization is created to deal with a new task. A new problem representation, that is to say, a role system, is created.

Creating an Organization

Some years ago I was fortunate enough to have a grandstand seat at the creation of the Economic Cooperation Administration, the U. S. governmental organization that administered the Marshall Plan of aid to Western European countries. In that process, which extended through most of the year 1948, competing problem representations emerged from the very first days, each implying a quite different organization structure, set of organizational roles, from the others. These problem representations were not made out of whole cloth, but arose from analogies between the presumed task of the ECA and other tasks that were familiar to the inventors of the representations from their previous training and experience.

For example, some participants in the planning drew an analogy between the ECA and wartime organizations that had supplied essential goods to the allies. Others thought of it as an exercise in investment banking. Others were reminded of the theory of international trade balances. From each of these views, a set of organizational roles could be inferred, and each

such structure of roles was quite different from the others. Which representations took root in which parts of the burgeoning organization depended heavily on the cultures from which these parts recruited their new members.

I have told elsewhere the story of how this competition was resolved (Simon, 1976, Chapter 16). One technique used was to disseminate a document that presented one of the representations (the one based on the balance of trade analogy) persuasively, and which mapped out its organizational implications. Another technique was to starve out the units dedicated to other representations by denying them new personnel.

Why Representation Matters

In my remarks thus far I have said only a little about bounded rationality -- about the limits upon the ability of human beings to adapt optimally, or even satisfactorily, to complex environments. Attention to the limits of human rationality helps us to understand why representation is important, and how policy statements imply representations. About a decade ago, the U. S. Steel Corporation began to contract its steel operations and to divert a major part of its capital to the acquisition of assets in the oil industry. The motivation of these moves was a particular representation of the corporation's purposes.

If, a few years ago, you had asked executives of U. S. Steel what the corporation's goals were, they might have answered: "To manufacture and market steel efficiently and profitably." If you had persisted further, they might even have agreed that profit was the "bottom line." But it would have been hard or impossible for them to describe the company without strong emphasis on its focus on steel. Their views might have been paraphrased: "We are out to make profits, but the way for us to make profits is to be an efficient steel manufacturer. That is a domain in which we have knowledge and expertise, and in which we can make good decisions."

For the conglomerate that U. S. X. has become, an entirely different representation is required. The Corporation has product divisions that can still be described in ways that resemble the earlier corporation -- the word "steel" applying to some divisions, and "oil" to others. But in the new representation, these divisions are only components operating within a larger framework in which the fundamental policy is to invest available funds in the directions that will yield the greatest returns. Within that framework, new expertise is required: essentially the expertise of an investment banker.

Change in representation implies change -- here very fundamental change -- in

organizational knowledge and skills. It should not be surprising that under these conditions we often see massive turnover of personnel at all levels. It is often cheaper and quicker to import the new expertise and dismiss the old than to engage in massive reeducation.

Conclusion

In this paper, my intent has been to show how concepts that have arisen in contemporary cognitive psychology for describing human learning and problem solving processes, and human expertise, can be applied to the analysis of organizational learning. I have made no attempt to be complete or comprehensive in my account. Instead, I have been satisfied to present some examples of how specific organizational situations can be understood in terms of these concepts.

Along the way, I have made a few comments on research strategy. I have remarked on how experiments may be useful for studying mechanisms. But above all else, I have emphasized the role of careful case studies in research on organizational learning. By "careful," I mean studies that explore the contents of important organizational memories, the ways in which those contents are accessed (or ignored) in the decision making process, and the ways in which they are acquired by organizations and transmitted from one part of an organization to another. Among the contents of organizational memories perhaps the most important are the representation of the organization itself and its goals, for it is this representation (or representations, if it is not uniform throughout the organization) that provides the basis for defining the roles of organization members.

If organization theory finds it useful to draw upon some of the ideas that have emerged in cognitive psychology, it will be advantageous to borrow also the terminology used in discussing these ideas. Without working toward a higher level of consistency in terminology than prevails in organization theory today, it will be difficult or impossible to cumulate and assemble into a coherent structure the knowledge we are gaining from individual case studies and experiments. We will be continually reinventing wheels. That is a luxury we cannot afford. The happy band of researchers on organization theory is sufficiently small to be kept fully occupied discovering and verifying the theory just once.

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